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Upgrade of a Cesium Iodide calorimeter for the KOTO experiment

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The KOTO experiment, conducted at J-PARC (Ibaraki Japan), is set to observe the rare decay $K_L \to \pi^0 \nu \bar{\nu}$.
Since the amplitude of $K_L \to \pi^0 \nu \bar{\nu}$ violates the charge conjugation and parity symmetries, the branching ratio is heavily suppressed in the Standard model (SM) and calculated to be $\mathcal{B}(K_L \to \pi^0 \nu \bar{\nu}) = (3.0 \pm 0.3) \times 10^{-11}$.
The experimental observation may reveal hints of physics beyond the SM.
The observed signature of $K_L \to \pi^0 \nu \bar{\nu}$ is two γ's produced from a π^0 and no other signal. Thus the KOTO detector consists of an electromagnetic calorimeter and hermetic veto counters.

The calorimeter, made of 50-cm-long Cesium Iodide (CsI) crystals, plays a crucial role in both the detection of photons, and the rejection of neutron-induced background.
%It is a key to reject accidental hits of neutron produced by beam to maintain the sensitivity.
Comparing the difference of waveforms and shower shapes between photon and neutrons, we have developed dedicated discriminators to achieve rejection of neutron contamination by a factor of ~ 100.
To reach the SM sensitivity, however, we need to reject neutron by another factor of ten.
In the summer of 2018, we are planning to instrument the front surface of CsI calorimeter with Multi Pixel Photon Counters (MPPC) to measure the timing difference between the arrival of signals at MPPCs and at photo multiplier tubes connected to the rear surface of the calorimeter.
The depth of energy deposition is measured through the timing difference, which in turn aids to discriminate neutron and photon.
In this presentation, we explain the performance of the developed system and the status of the calorimeter upgrade.

Secondary topics

neutron gamma separation

Applications

Design concepts for future calorimeter at the intensity frontier

Primary topic

Crystals

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